Specification

Electronic Module, in Particular a Multichip Module, Comprising a Multilayer Wiring and Method of Making the Same.

The invention relates to an electronic module, in particular a multichip module, comprising a multilayer wiring having at least one IC component applied on the component side thereof, said module being unilaterally covered on the component side with a hermetic case, and comprising contact pads on the bottom side of the module through which contacting and integration of the module to a next higher assembly group level can be established.

The invention moreover relates to a method of making an electronic module, in particular a multichip module, comprising a multilayer wiring.

The increasing reduction in size and growing speed of integrated circuits meets with increasing demands on the extension and connection technology thereof. Multichip modules have been known for some tome through which an intermediate carrier substrate with high wiring density, HDI (High Density Interconnect), is introduced into the hierarchy of the system structure as an additional level. Typical in this respect is the use of a plurality of unpackaged chips as well as a high area coverage of the multichip substrate. A similar known new development relates to the chip size package (CSP) in which a single unpackaged chip is applied to an intermediate carrier substrate which is hardly larger than the chip area and in which the space-saving contacting to the next architectural level directly under the chip area is utilized.

The essential features of today's packages for single-chip or multichip applications are the lateral dimension, the construction height, the heat dissipation and the pitch in the next architectural level. The utilization of the known quad flat pack (QFP) packages, in addition to the relatively low degree of chip coverage (chip area/component area) and the relatively high construction height, involves the additional disadvantage of the transition to extremely small pitches on the motherboard with high pincount of the chips. There is also known an additional package type, the ball grid arrays (BGA). In case of these, small solder balls applied over the area or in sheet-like manner on the bottom side of the module in a relatively coarse grid pattern, constitute the terminals. By means of BGA constructions, the arrangement of the contacts in sheet-like manner assists in mitigating the problems concerning the pitch, and the construction height can be reduced in principle. However, the manufacture of conventional laminate/plastics interconnects, in particular for high-density wirings, results in technical detours and disadvantageous product properties. In total, the current situation presents itself as follows:

The technologies of circuit board production render possible wiring substrates permitting electric through-contacting from the chip side to the bottom side by means of plated-through holes that can be made in relatively simple manner. They are less advantageous as regards the production of constructional shapes of small lateral dimensions, in particular for multichip modules, as the wiring densities are too low. Furthermore, in particular vias between the conductive track levels are not positioned in sufficiently exact manner due to the shrinkage of the laminate materials. There are left uncertainties of typically up to 200 µm, and this is brought to regis-

tration by a coarser design of the structure around the via (land). Due to the shrinkage, high-density wiring substrates can be realized only if the production is not carried out on the inexpensive large panels, for example of 600 x 600 mm, but on extremely small ones, for example of 150 x 150 mm. Large-format production in circuit board technology thus involves high costs comparable to those in thin-film technology.

The technologies of thin-film production permit high wiring densities due to their processes employing fine structures, and there is no shrinkage problem due to the rigid substrate materials (the substrate proper for the multilayer wiring consists of ceramic, silicon, glass or metal). However, there are problems arising with other aspects of this technology, in particular as regards the cost-intensive detours, such as drilling or punching holes in the rigid core materials, adjustment problems, metallization of the holes, etc., as necessary in realizing the electrical connection from the substrate top side to the substrate bottom side. In addition thereto, the density of the plated-through holes is restricted by the substrate thickness and the respective technology for making the hole. In general, there is poor compatibility between the technology of substrates with holes on the one hand and processes in thin-film technique, for example spin coating, on the other hand. Finally, there is also a high risk of breakage of the substrates in the thin-film process which moreover does not permit a simple change to inexpensive large-format production, either.

It is the object of the present invention to provide an improved module of the type indicated at the outset, having in particular a reduced construction height, and to indicate a method of making the same.

With a module of the type indicated at the outset, this object is met in that the component side of the multilayer wiring adheres to the hermetic case with its portions that are free from components, and in that the bottom side of the multilayer wiring having a height of less than approx. 100 µm, directly, i.e. without additional wiring substrate, constitutes the bottom side of the module.

With a method of the type indicated at the outset, the object is met in that a multilayer wiring having contact pads on the bottom side thereof is applied only to the top side of a plate-shaped wiring substrate of rigid material, that IC components and additional electronic components, respectively, are electrically and mechanically connected to the component level of the multilayer wiring, that the component side of the multilayer wiring is provided with a hermetic case adhering in the portions thereof that are free from components, and in that the rigid substrate material is removed again thereafter and the bottom side of the multilayer wiring, which constitutes the bottom side of the module, is exposed.

Further developments of the invention are subject matter of the dependent claims.

The invention will be elucidated in more detail hereinafter by way of embodiments in connection with the drawing figures in which

Figs. 1A to 1D show cross-sectional side views of successive stages of the manufacturing process according to the invention in a first embodiment,

Figs. 2A to 2F show corresponding views of another embodiment,

Figs. 3A to 3F show corresponding views in a further embodiment.

The invention achieves the desired improvements in that not only the processes of the interconnect production proper are taken into consideration, but in that the overall process for making a BGA standard package is incorporated in the rationalization and restructuring of the process sequences according to the invention and thus of the module itself. According to the invention, it is possible to produce ultra-thin modules although the utilization of the advantages of thin-film technique, i.e. in particular the use of rigid substrate materials or materials of high temperature stability (up to 400 °C) is maintained on the one hand, whereas on the other hand a high wiring density can be achieved in unrestricted manner and large-size panels, for example 400 x 400 mm, can be used for the production. In addition thereto, there is the advantage that process steps can be dispensed with.

Fig. 1A shows a metallic wiring substrate 1 having already applied on the top side thereof the interconnect proper, i.e. the multilayer wiring 2, which is constituted by a sequence of structured metal planes or levels that are electrically separated from each other by insulating layers and between which purposeful electric connections are established through vias. Suitable substrate materials are, for example, copper or aluminium. It is of crucial importance that the multilayer wiring 2 actually is applied on the substrate top side only and that there are no plated-through holes made from the top side to the bottom side of wiring substrate 1. Fig. 1 shows a module in which, compared with Fig. 1A, two additional production steps have been carried out, namely mechanical and electrical connection of one or more

chips 3 and, optionally, of additional electronic components to the component side of the multilayer wiring 2, for example by chip and wire bond technique or flip chip technique, with the equipped system being then brought into the configuration of a standard package by unilateral plastics molding (overmold), cp. case 4. The largest part of the component area, i.e. of the top side of the multilayer wiring 2, is free from components so that the casting or adhesive compound 4 applied can establish sufficient adhesive areas 5 towards the multilayer wiring 2. In particular, the usual casting compounds may be employed as these are compatible anyway, i.e. capable of adhering, to the insulating materials used as uppermost layer of the multilayer wiring 2, such as polyimide, PBO, BCB or ormocere.

Fig. 1C shows a module in which the next process step, the removal of the substrate material 1, has already been carried out. This can be achieved, for example, by dissolution of the substrate material, in particular by wet chemical etching in one of the etch plants usual in the trade, as used for example in high-integration semiconductor technology. Thereafter and due to this, the contact pads 6 on the bottom side of the multilayer wiring 2, which by means of vias and connections to the conductive track system are to ensure the electrical contact of the components 3 of the module to the contacts of the next higher assembly group level, of course are exposed as well. As shown in Fig. 1D, this is usually followed by the application of solderable material, in particular soldering balls 7, to the contact pads 6 for establishing contact to the module. A passivation layer 15 may be provided to permit easier testing of the module later on, cp. Fig. 1B. Basically, e.g. plastics material is possible as substrate material as well.

While Figs. 2A and 2B correspond to the manufacturing steps according to Fig. 1A and 1B, Figs. 2C and 2F show embodiments differing therefrom. Fig. 2C shows the result of etching pits 8 into the substrate material from the bottom side, so that the contact locations, i.e. the contact pads 6 on the bottom side of the multilayer wiring 2 are exposed. Thereafter, solderable material 9 (e.g. SnPb) can be introduced into the pits 8 by electroplating, or solder balls 7 can be introduced into the pits 8 by standard processes, cp. Fig. 1D. Only thereafter is the removal of the wiring substrate 1 carried out, with modules according to Fig. 2E or 2F being the final result depending on the type of solder material 8, 9 chosen.

As an alternative to the removal of the substrate material by dissolution as described hereinbefore, another suitable possibility of separation consists in stripping the wiring substrate 1 from the multilayer wiring 2. This can be realized in particular by application of an intermediate layer between multilayer wiring 2 and wiring substrate 1. For example, a low melting point material, e.g. solder, or an adhesive is well suited, which at the end of the molding process permits separation of the module from the wiring substrate 1, for example, by means of an additional heat treatment step. Figs. 3A to 3E display a process sequence in which a solder layer 10 as intermediate layer is applied to the substrate material first, which then is covered with a structured insulating layer 11. According to Fig. 3C a structured metal plane 12 is made, which according to Fig. 3D is equipped with electronic components and covered by a hermetic case 4. Fig. 3E shows the final result after heating of the solder layer 10 and removal of the wiring substrate 1, with harmless residues of the solder layer 10 being left at the solder pads 10, and only there. Within the conductive track system of the multilayer

wiring 2, which in this special case permitting particularly inexpensive production consists of one single metal and one single insulating layer 12 and 11 only, the metal lands 13 and 14 are connected to each other. When an adhesive is used as intermediate layer, care should be taken that the same is as residue-free as possible, or post-cleaning should be provided for.

According to the invention, the result achieved consists in a module in the form of a BGA standard package having an extremely low assembly height, since the sole remaining multilayer wiring 2, the interconnect proper, has an assembly height of less than approx. 100 µm, mostly even less than 60 µm. Due to the fact that the chips 3 in thinned form typically have a height of approx. 300 µm and the hermetic case 4 once more takes a similar height, minimum package heights (without balls) of approx. 600 µm can be achieved according to the invention, whereas for example in laminate technology the known interconnect alone, i.e. the wiring substrate with the multilayer wiring arranged thereon has a height between 500 µm and 1000 µm.